SUBSTITUTE SPECIFICATION

RADIO INFORMATION COMMUNICATING SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is an invention relating to a radio information communicating system. More particularly, the present invention is an invention relating to a radio information communicating system in which one access relaying apparatus and one or more radio communication terminals constitute a local network to mutually perform radio data communication.

2. Description of the Related Art

One information communication standard for wireless local area networks (LANs) is IEEE 802.11. For IEEE 802.11, DCF (Distributed Coordination Function) using carrier sense multiple access with collision avoidance (CSMA/CA) is proposed as a standard function.

Here, under the above-mentioned DCF, a radio terminal holding a packet monitors a radio transmission line by carrier sensing and if the radio transmission line is open, performs a transmission of the packet. Conversely, if the radio transmission line is not open, the radio terminal retransmits the held packet after an interval determined by a random number based on a back-off process. Similarly, if a collision between packets occurs, the radio

terminal retransmits the aforementioned packet after an interval determined by a random number (e.g., Japanese Laid-Open Patent Publication No. 09-205431).

BRIEF SUMMARY OF THE INVENTION

However, while allowing for light control, the aforementioned DCF has a problem described below.

An audio packet has such characteristics that it is abandoned due to time-out if it is held in an unsent state beyond a predetermined time within a wireless LAN. Here, under the aforementioned DCF, because of the occurrence of collisions between packets and a back-off process, a delay in a packet transmission is prone to happen. Consequently, the aforementioned DCF has a problem in that there is a high possibility of abandoning the audio packet in an unsent state within the system.

As a method for solving the above-mentioned problem, PCF (Point Coordination Function) using polling by a radio base station may be conceivable. PCF is a communication method in which a radio base station sequentially grants each radio terminal a transmission right and the radio terminal having obtained the transmission right performs a transmission of a packet. Thus, the radio terminal having obtained a transmission right can periodically transmit packets of data. As a result, abandonment of an audio packet due to the above-mentioned time-out is less likely to occur.

Nevertheless, the aforementioned PCF has problems in that,

since a radio base station must manage and control all radio terminals, there is a heavy control load, and that because polling is periodically performed even to a radio terminal generating packets in burst fashion, it is ineffective.

Therefore, an object of the present invention is to provide a wireless LAN system which can be controlled, without a heavy load on the whole system, in such a manner that specific data such as audio data will not be abandoned within a radio terminal at the transmitting end due to time-out.

To solve the aforementioned conventional problems, a radio information communicating system of the present invention normally transmits a packet by CSMA/CA, and when the packet is about to be abandoned due to time-out, an access point (AP) performs polling to a radio terminal which is trying to transmit the packet.

According to the above-mentioned radio information communicating system, an AP does not need to perform polling constantly. As a result, the control load on the AP is reduced. Moreover, because a radio terminal is compulsorily granted a transmission right through polling, abandonment of a packet due to time-out is prevented.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a radio information communicating system of the present invention.

FIG. 2 is a diagram illustrating a packet used in the radio

information communicating system of the present invention.

FIG. 3 is a diagram illustrating a radio terminal used in the radio information communicating system of the present invention.

FIG. 4 is a block diagram illustrating a Media Access Control Baseband (MAC/BB) processing section included in a radio terminal in the radio information communicating system of the present invention.

FIG. 5 is a diagram illustrating an access point (AP) used in the radio information communicating system of the present invention.

FIG. 6 is a block diagram illustrating a MAC/BB processing section included in the AP in the radio information communicating system of the present invention.

FIG. 7 is a flowchart illustrating an operation performed by the MAC/BB processing section of a radio terminal when various areas are embedded to a packet.

FIG. 8 is a flowchart illustrating an operation of an internal CPU of a radio terminal when a packet is stored in a sending/receiving FIFO.

FIG. 9 is a flowchart illustrating the process which the AP performs when receiving a packet.

FIG. 10 is a flowchart illustrating an operation performed by a MAC/BB processing section 102a of a radio terminal 2a, when subsequent packets are transmitted.

DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, a radio information communicating system according to an embodiment of the present invention will be described with reference to the figures. FIG. 1 is a block diagram illustrating a radio information communicating system according to an embodiment of the present invention.

The radio information communicating system shown in FIG. 1 comprises an access point (hereafter, referred to as AP) 1 and radio terminals 2a to 2d. This radio information communicating system is a wireless LAN system, in which radio information communications are conducted between each of the radio terminals 2a to 2d or the AP 1. Now, the entire overview of the radio information communicating system shown in FIG. 1 will be briefly described.

In this radio information communicating system, the AP 1 and each of the radio terminals 2a to 2d normally perform data communication through CSMA/CA. Specifically, the AP 1 and the radio terminals 2a to 2d perform carrier sensing for a communication path that each device is trying to use, and, if transmission is possible, transmit a packet of data to the AP 1 or one of the radio terminals 2a to 2d. Here, if a packet of data is a packet of audio data and the packet is about to be abandoned due to time-out, the radio terminals 2a to 2d according to the present embodiment are granted a transmission right from the AP 1 through polling. Thus,

the radio terminals 2a to 2d which have been granted the transmission right, switch the data communication method from CSMA/CA to a polling technique and, without abandoning the packet due to time-out, are able to transmit the packet to the counterpart radio terminals 2a to 2d.

When a packet of audio data held by one of the radio terminals 2a to 2d is about to be abandoned, the AP 1 needs to recognize when a packet to be transmitted next to this packet would be abandoned due to time-out for a transmission right to be granted.

Therefore, the radio terminals 2a to 2d embed predetermined information in the packet of data and transmit the packet to the AP 1 and the radio terminals 2a to 2d. Hereafter, the construction of the packet of data will be described with reference to the figures. FIG. 2 is a diagram illustrating the construction of a packet of data according to the present embodiment.

First, a packet of data according to the present embodiment comprises a control header 51, a payload section 54, a packet abandonment time area 52, a remaining packet flag area 53, and a frame check sequence (FCS) 55. The control header 51 is a header portion containing information such as a transmission destination of this packet. The payload section 54 contains the actual data. The packet abandonment time area 52 contains information of a time (a packet abandonment time) until a subsequent packet to be transmitted is abandoned due to time-out. For example, the packet abandonment time is expressed by a number of 10 levels; and the

packet abandonment time is decreased by one every two seconds. When the number becomes 0, the subsequent packet is abandoned.

The remaining packet flag area 53 shows whether a subsequent packet exists. More specifically, the remaining packet flag area 53 is expressed in data of 1 bit. If the bit is 0, a next packet does not exist, and if it is 1, a next packet exists. An FCS (Frame Check Sequence) is a 32-bit cyclic redundancy check (CRC) for checking whether received data is correct or not.

Hereafter, the radio terminals 2a to 2d and the AP 1 in the radio information communicating system according to the present embodiment is described with reference to the figures. FIG. 3 is a block diagram illustrating the radio terminals 2a to 2d according to the present embodiment. FIG. 4 is a block diagram illustrating the detailed constitution of a MAC/BB processing section 102a in the radio terminals 2a to 2d. In addition, FIG. 5 is a block diagram illustrating the AP 1 according to the present embodiment. FIG. 6 is a block diagram illustrating the MAC/BB processing section 102b in the AP 1 according to the present embodiment.

First, the radio terminals 2a to 2d according to the present embodiment perform data transmission/reception through mutual radio communication. Each of the radio terminals 2a to 2d comprise a high frequency processing section 101a, a MAC/BB processing section 102a, a CPU 103a, a wired I/F 104 for a terminal, and a terminal 105.

The high frequency processing section 101a demodulates a radio signal transmitted from one of the other radio terminals 2a to 2d or from the AP 1 and converts the radio signal to an electric signal. Additionally, the high frequency processing section 101a modulates an electric signal outputted from the MAC/BB processing section 102a and outputs the electric signal as a radio signal.

The MAC/BB processing section 102a, as shown in FIG. 4, comprises an internal CPU 201a, a frame processing section 202a, a sending/receiving FIFO 203a, a MAC protocol processing section 204a, a bus bridge 205a, and switches between data communication based on CSMA/CA and data communication based on polling depending on the state of communication with the radio terminals 2a to 2d. The CPU 103a, shown in Fig. 3, controls the flow of a packet within the radio terminals 2a to 2d. More specifically, the CPU 103a forwards a packet inputted from an external network via the wired I/F 104 to the MAC/BB processing section 102a, and forwards a packet outputted from the MAC/BB processing section 102a to the wired I/F 104. The terminal 105 is an information terminal such as a personal computer and creates a packet to be transmitted.

Each constituent section of the MAC/BB processing section 102a is described below. The bus bridge 205a connects two busses and outputs the packet outputted from the wired I/F 104 to the frame processing section 202a. The frame processing section 202a adds the packet abandonment time area 52 and the remaining packet flag area 53 to the packet of data and outputs the packet to the

sending/receiving FIFO 203a. The sending/receiving FIFO 203a outputs the packet to the high frequency processing section 101a, based on an instruction from the MAC protocol processing section 204a. The MAC protocol processing section 204a normally performs carrier sensing for a radio transmission line by CSMA/CA and, if the radio transmission line is in an open state, the MAC protocol processing section 204a instructs the sending/receiving FIFO 203a to output the packet. Additionally, if a transmission right is granted from the AP 1 through polling, the MAC protocol processing section 204a causes the sending/receiving FIFO 203a to transmit the packet held thereby. The internal CPU 201a measures time, and periodically accesses the sending/receiving FIFO 203a, and decreases the packet abandonment time area 52 of the packet stored in the sending/receiving FIFO 203a by one each. Note that the cycle with which the internal CPU 201a accesses the sending/receiving FIFO 203a and the time taken for the packet abandonment time area 52 to be decreased by one, need to be matched.

Next, with reference to the figures, the AP 1 will be described. FIG. 5 is a block diagram illustrating the AP 1. The AP 1 and the radio terminals 2a to 2d have substantially the same hardware. Consequently, any element having the same hardware is denoted by the same reference numeral with the end "a" being replaced with "b".

The AP 1 transmits packets of data inputted from the external network to the radio terminals 2a to 2d in the form of electric

waves, and receives electric waves transmitted from the radio terminals 2a to 2d and transmits packets of data to the external network. The AP 1 comprises a high frequency processing section 101b, a MAC/BB processing section 102b, a CPU 103b, and an Ethernet (R) I/F 304.

Here, the high frequency processing section 101b is identical to the MAC/BB processing section 102a of the radio terminals 2a to 2d, and therefore, the description is omitted.

The MAC/BB processing section 102b, as shown in FIG. 6, includes an internal CPU 201b, a frame processing section 202b, a sending/receiving FIFO 203b, a MAC protocol processing section 204b, a bus bridge 205b, and switches data communication by CSMA/CA to data communication by polling in accordance with the state of communication with the radio terminals 2a to 2d. The CPU 103b controls the flow of a packet within the AP 1. More specifically, the CPU 103b forwards the packet inputted from the external network via the Ethernet (R) I/F 304 to the MAC/BB processing section 102b, and forwards the packet outputted from the MAC/BB processing section 102b to the Ethernet (R) I/F 304. The Ethernet (R) I/F 304 converts the format of the packet from a format appropriate for the external network to a format appropriate for the wireless LAN network, and converts the format of the packet from a format appropriate for the wireless LAN network to a format appropriate for the external network.

Each constituent section of the MAC/BB processing section

102b is described below. The bus bridge 205b is identical to the bus bridge 205a of the radio terminals 2a to 2d, and therefore the description is omitted. The frame processing section 202b acquires the packet abandonment time area 52 and the remaining packet flag area 53 from the received packet. The received packet of data is stored temporarily in the sending/receiving FIFO 203. The internal CPU 201b measures time, accesses the frame processing section 202b periodically, and decrements the packet abandonment time for the packet acquired by the frame processing section 202b by one each. If a next packet is not received even when the packet abandonment time of the packet received last is 1, the MAC protocol processing section 204b creates a polling packet for the purpose of granting a transmission right to the radio terminals 2a to 2d based on polling.

An operation of the radio information communicating system constituted as above will be described below. Each process presented in the present embodiment can be realized with software using a computer, or by using a dedicated hardware circuit conducting each process.

A case where the radio terminal 2a transmits data to the radio terminal 2b will be described. When the radio terminal 2a transmits data to the radio terminal 2b, each area, such as the packet abandonment time area 52, is embedded to the packet of data to transmit. Therefore, with reference to FIG. 7, an operation of the radio terminal 2a is described below. FIG. 7 is a flowchart

illustrating an operation of the frame processing section 202a of the MAC/BB processing section 102a in the radio terminal 2a at the time of the packet transmission from the radio terminal 2a to the radio terminal 2b, when each area is embedded into each packet.

First, the terminal 105 outputs the packet of data to be transmitted to the wired I/F 104. In response, the wired I/F 104 converts the received packet from a format appropriate for the terminal 105 to a packet format appropriate for the wireless LAN and, in accordance with an instruction from the CPU 103a, outputs the packet to the MAC/BB processing section 102a.

The packet inputted to the MAC/BB processing section 102a is inputted to the frame processing section 202a via the bus bridge 205a and a bus. The frame processing section 202a thereby acquires the packet (step S5).

Next, the frame processing section 202a determines whether the packet acquired is an audio packet (step S7). If the acquired packet is not an audio packet, the process proceeds to step S15. Otherwise, the process proceeds to step S10.

If the acquired packet is an audio packet at step S10, the frame processing section 202 adds the control header 51, the packet abandonment time area 52, the remaining packet flag area 53, and the FCS 55 to the acquired packet. The frame processing section 202 embeds the number "10" in the packet abandonment time area 52, and embeds the number "1", indicative of an existence of a

next or subsequent packet, in the remaining packet flag area 53. If a next or subsequent packet does not exist, the frame processing section 202 embeds the number 0 in the remaining packet flag area 53. Thereafter, the process proceeds to step S15.

At step S15, the frame processing section 202 outputs the packet to the sending/receiving FIFO 203a. Processing then returns to step S5 and the frame processing section 202 performs the same process for the next or subsequent packet. Thus, packets are successively inputted to the sending/receiving FIFO 203a from the frame processing section 202. The packets will thus be stored in the sending/receiving FIFO 203a.

Among the packets stored in the sending/receiving FIFO 203a, the MAC protocol process section 204a transmits the first packet of the data to be transmitted, through CSMA/CA. Specifically, the MAC protocol process section 204a performs carrier sensing for a radio transmission line which the device is going to use for transmission, and if the radio transmission line comes to an open state, transmits the packet using CSMA/CA. In the present embodiment, because the radio terminal 2a is trying to transmit the packet to the radio terminal 2b, the radio terminal 2a monitors the usage state of the radio transmission line between the radio terminal 2a and 2b.

If the MAC protocol process section 204a determines that a transmission of data is possible, the first packet of the data to be transmitted, among the packets stored in the

sending/receiving FIFO 203a, is outputted to the high frequency processing section 101a, subjected to an RF process at the high frequency processing section 101a, and then transmitted to the AP 1 and the radio terminal 2b. In response, the AP 1 and the radio terminal 2b receive the packet transmitted from the radio terminal 2a. The packet, according to the present embodiment, is transmitted to both the AP 1 and the radio terminals 2a to 2d. This is in order to allow the AP 1 to recognize when the next or subsequent packet to the transmitted packet is to be abandoned.

The transmitting radio terminal 2a must manage the time in which the next or subsequent packet it is holding will be abandoned. Therefore, an operation performed by the internal CPU 201a in the radio terminal 2a, when the packet is stored in the sending/receiving FIFO 203a of the radio terminal 2a, is described below with reference to the figures. FIG. 8 is a flowchart illustrating the operation which the internal CPU 201a performs at this time.

In the present embodiment, one or more packets are stored in the sending/receiving FIFO 203.

The internal CPU 201a measures time and accesses the sending/receiving FIFO 203a at the predetermined time interval. As mentioned above, the predetermined time is the time it takes to decrease the packet abandonment time by one. In the present embodiment, the predetermined time is two seconds.

The internal CPU 201 determines whether the predetermined

time has elapsed since previously accessing the sending/receiving FIFO 203 (step S50). If the predetermined time has not elapsed, the process returns to step S50. Otherwise, the process proceeds to step S55.

If the predetermined time has elapsed, the internal CPU 201 refers to the packet abandonment time area 52 of the packet stored in the sending/receiving FIFO 203a (step S55). Then, the internal CPU 201 decreases the value of the referred packet abandonment time by one (step S60).

Next, whether the packet currently in process is the last packet among that stored in the sending/receiving FIFO 203a is determined (step S65). This determination process takes place by referring to the remaining packet flag area 53. If it is the last packet, since the packet abandonment time of all packets is rewritten, the process returns to step S50. Otherwise, the process proceeds to step S70.

If it is not the last packet, the internal CPU 201a refers to a next or subsequent packet within the sending/receiving FIFO 203a (step S70). Thereafter, the process returns to step S55 and the internal CPU 201a applies processes similar to step S55 and step 60 to the packet referred at step S70.

Through the above operation, the packet abandonment time is managed in the transmitting radio terminal 2a.

Next, operations to be performed when the radio terminal 2b and the AP 1 receive a packet transmitted from the radio terminal

2a will be described. Because the process performed when the radio terminal 2b receives a packet is the same as a process performed by a conventional commonly-used wireless LAN system, the description is omitted.

The process performed when the AP 1 receives a packet is described with reference to the figures. FIG. 9 is a flowchart illustrating an operation performed by the MAC/BB processing section 102b of the AP 1.

A packet transmitted from the radio terminal 2a is received by the high frequency processing section 101b. The high frequency processing section 101b converts the received packet to a format capable of being processed at the MAC/BB processing section 102b, and outputs the received packet to the MAC/BB processing section 102b. In response, the frame processing section 202b of the MAC/BB processing section 102b acquires the packet (step S100).

The frame processing section 202b determines whether the packet is an audio packet (step S105). The determination as to whether it is an audio packet is conducted through determining whether the remaining packet flag area 53 and the packet abandonment time area 52 exist in the packet. If the packet is an audio packet, the process proceeds to step S110. Otherwise, the process ends.

If the packet is an audio packet, the frame processing section 202b refers to the remaining packet flag area 53 to determine whether a next packet exists (step S110). This determination is made through determining whether the number in the remaining packet

flag area 53 is "1". If a subsequent packet exists, the process proceeds to step S115. Otherwise, the process ends.

If a subsequent packet exists, the frame processing section 202b acquires the packet abandonment time area 52 contained in the packet (step S115). Then, the frame processing section 202b outputs the packet to the sending/receiving FIFO 203b.

The internal CPU 201b measures time in synchronization with the internal CPU 201a of the radio terminals 2a to 2d, and accesses the frame processing section 202 with the same timing as the internal CPU 201a accesses the sending/receiving FIFO 203a, at the predetermined time interval. The predetermined time is the time it takes to decrease the number in the packet abandonment time area 52 by one. The predetermined time is two seconds in the present embodiment.

The internal CPU 201b determines whether the predetermined time has elapsed since previously accessing the frame processing section 202b (step S120). If the predetermined time has elapsed, the process proceeds to step S125. Otherwise, the process returns to step S120.

If the predetermined time has elapsed, the internal CPU 201b accesses the frame processing section 202b and decreases the number contained in the packet abandonment time area 52 by one (step S125). Next, the frame processing section 202b refers to the packet abandonment time area 52 to determine whether the packet abandonment time is "1" (step S130). If the packet abandonment

time is "1", the process proceeds to step S135.Otherwise, because there is enough time left till the next packet is abandoned, the process returns to step S120.

If the packet abandonment time is "1", the internal CPU 201b determines whether the AP 1 has received a next or subsequent packet to the packet currently being processed (step S135). If a next or subsequent packet has been received, the process returns to step S115 and the MAC/BB processing section 102b conducts the processes of step S115 to step S135 for the next packet. Otherwise, the process proceeds to step S140.

If a next packet has not been received, the internal CPU 201b notifies the MAC protocol processing section 204b. In response, the MAC protocol processing section 204b creates a polling packet for the purpose of granting a transmission right to the radio terminal 2a (step S140). The MAC protocol processing section 204b transmits the polling packet to each of the radio terminals 2a to 2d in the wireless LAN area via the high frequency processing section 101b (step S145). The radio terminal 2a is thereby granted a transmission right based on polling. Thereafter, in response to the polling packet, the packet is transmitted from the radio terminal 2a; at step S100, the packet is received.

Next, an operation at the time when the radio terminal 2a transmits a subsequent packet to the radio terminal 2b will be described. As mentioned above, the first packet is transmitted to the radio terminal 2b at the transmitted end through CSMA/CA.

Otherwise, subsequent packets are transmitted through CSMA/CA in principle. When a packet is about to be abandoned due to time-out, the subsequent packets are transmitted through polling. Now, with reference to the figures, an operation performed by the MAC/BB processing section 102a of the radio terminal 2a when the subsequent packets are transmitted will be described below. FIG. 10 is a flowchart illustrating an operation performed by the MAC/BB processing section 102a.

Using CSMA/CA, the MAC protocol processing section 204a performs carrier sensing for a radio transmission line which the device is trying to use (step S200). Next, the MAC protocol processing section 204a determines if it is possible to transmit a packet by determining whether the radio transmission line is available (step S205). If it is possible to transmit a packet, the process proceeds to step S210. Otherwise, the process proceeds to step S215.

If it is possible to transmit a packet, the MAC protocol processing section 204a causes the oldest packet among the packets stored in the sending/receiving FIFO 203a to be transmitted to the AP 1 and to the radio terminal 2b, via the high frequency processing section 101a (step S210). In response, the AP 1 and the radio terminal 2b receive the packet. Upon receiving the packet at the AP 1, the process presented in the flowchart of FIG. 9 is conducted. Thereafter, the process returns to step S200 and a similar process is performed for the next or subsequent packet.

If it is not possible to transmit the packet, the MAC protocol processing section 204a determines whether a polling packet from the AP 1 has been received (step S215). If a polling packet has been received, the process proceeds to step S220. Otherwise, the process returns to step S200.

If a polling packet has been received, it indicates that the radio terminal 2a is granted a transmission right to transmit the packet to the radio terminal 2b. Therefore, the radio terminal 2a transmits the oldest packet among the packets stored in the sending/receiving FIFO 203a to the AP 1 and to the radio terminal 2b via the high frequency processing section 101b (step S220). In response, the AP 1 and the radio terminal 2b receive the packet. Upon receiving the packet at the AP 1, the process shown in the flowchart of FIG. 9 is conducted. Thereafter, the process returns to step S200 and a similar process is performed for the next packet.

As aforementioned, in accordance with the radio information communicating system of the present embodiment, since an AP grants a radio terminal a transmission right based on polling when a packet is about to be abandoned, abandonment of a packet is avoided.

Furthermore, since control using polling technique only takes place when a packet is about to be abandoned and is not conducted constantly, the control load on the AP is reduced as compared to the case where control using polling technique is always performed.

In the present embodiment, packet communication between

radio terminals is only described; however, this method of data communication is also applicable to the case where a packet is transmitted from a radio terminal to an AP. In this case, the function of the MAC/BB processing section in the AP should only be the same as that of the MAC/BB processing section in the radio terminal. The packet transmitted from a radio terminal to an AP may be a packet transmitted to an external network or may also be a packet transmitted to a radio terminal within the wireless LAN.

The radio information communicating system as described herein has an effect of being controllable such that specific data such as audio data will not be abandoned within a radio terminal at the transmitting end due to time-out, without imposing a heavy control load on the whole system. Moreover, the radio information communicating system as described herein is effective as a radio information communicating system, or the like, in which one access relaying apparatus and one or more radio communication terminals constitute a local network to mutually perform radio data communication.